



***DARPA*Tech**

2002 Symposium

Transforming
Fantasy



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Moletronics: **Transforming** **Nanotechnology and** **Nanocomputers** **from Vision to Reality**

Dr. Kwan S. Kwok



Nanotechnology

- ▶ Utilizing the properties of molecules
- ▶ Organizing matter on the molecular scale--i.e, the nanometer scale
- ▶ Building nanocomputers and advanced nanomaterials



Plan for Revolutionary Change: *Building Nanocomputers*

(1) Molecular Devices

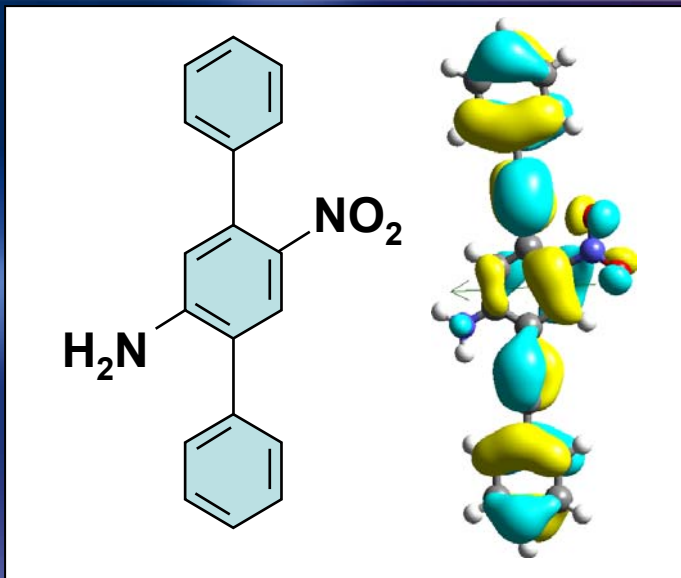
(2) Molecular Circuits

(3) Self-Assembly

(4) Ultra-dense Architectures

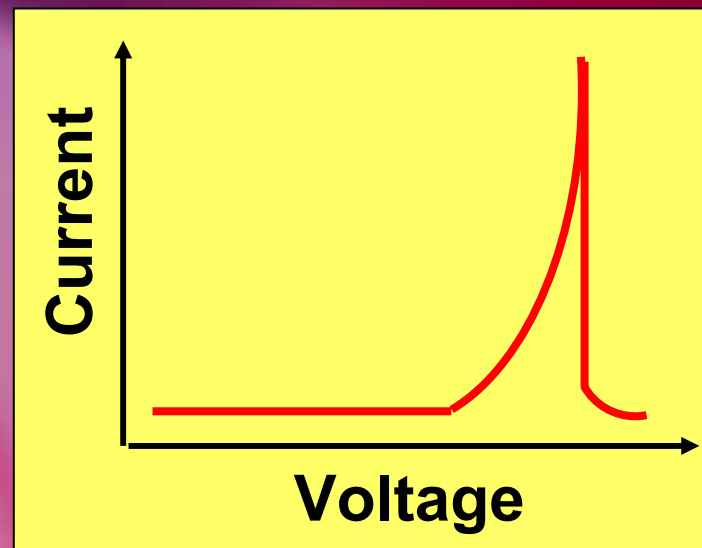


Demonstrated Molecular Devices



- Current densities much greater than copper wire

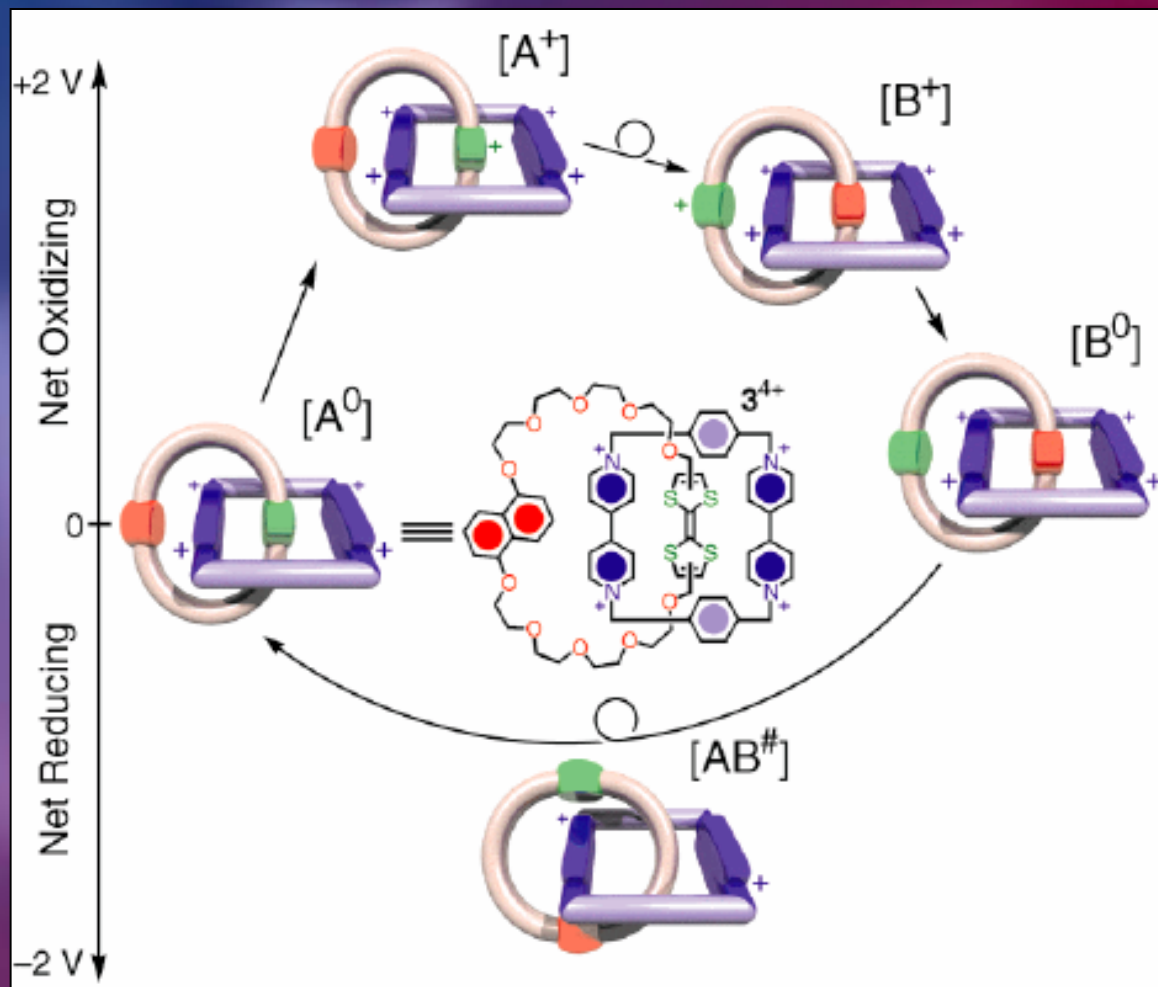
- Individual molecules shown to conduct and switch electricity



Rice-Yale switch

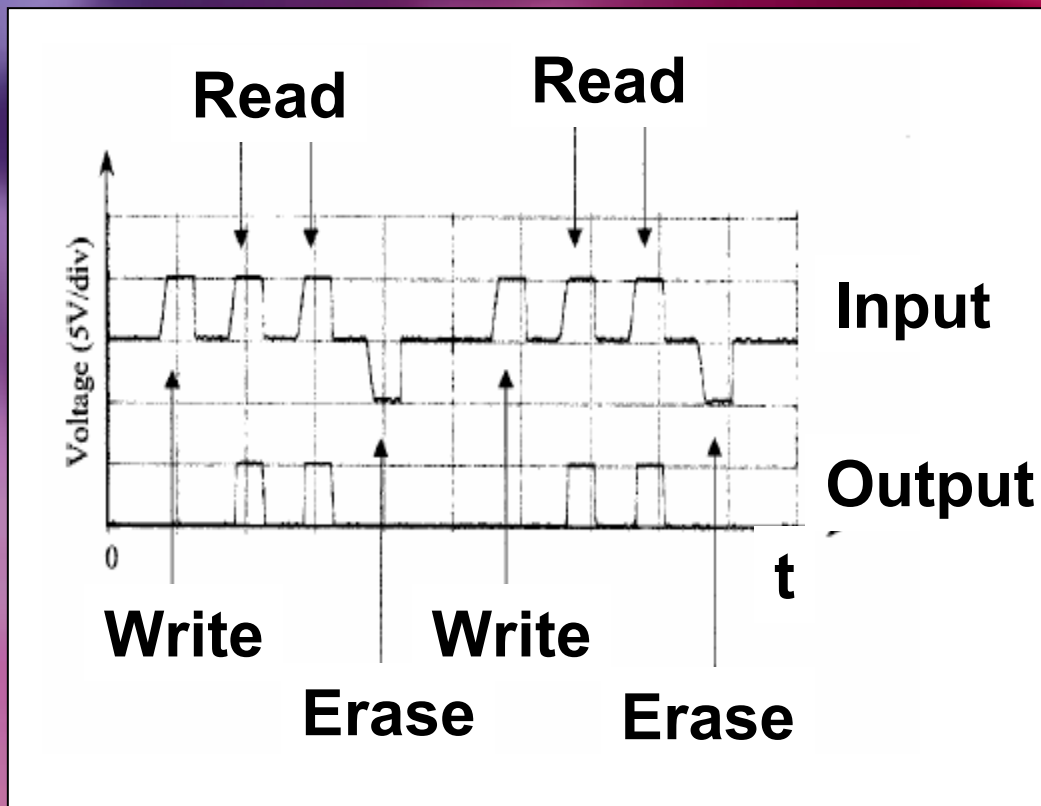
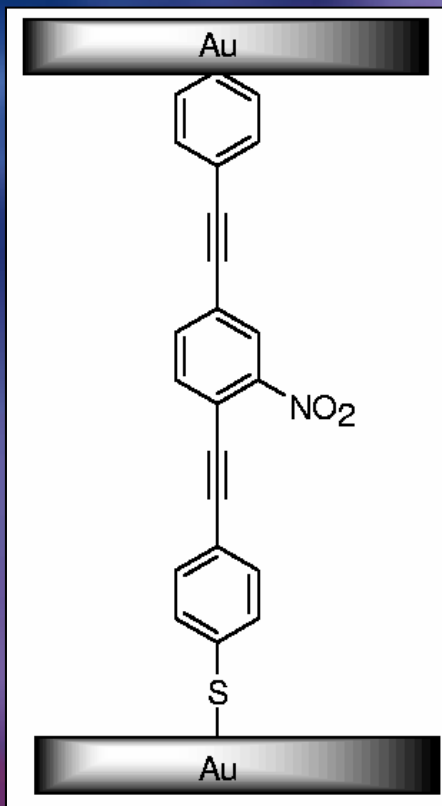
Demonstrated Molecular Devices

H-P/UCLA Molecular Switch



Demonstrated Molecular Circuits

Rice-Yale Molecular Memory Cell



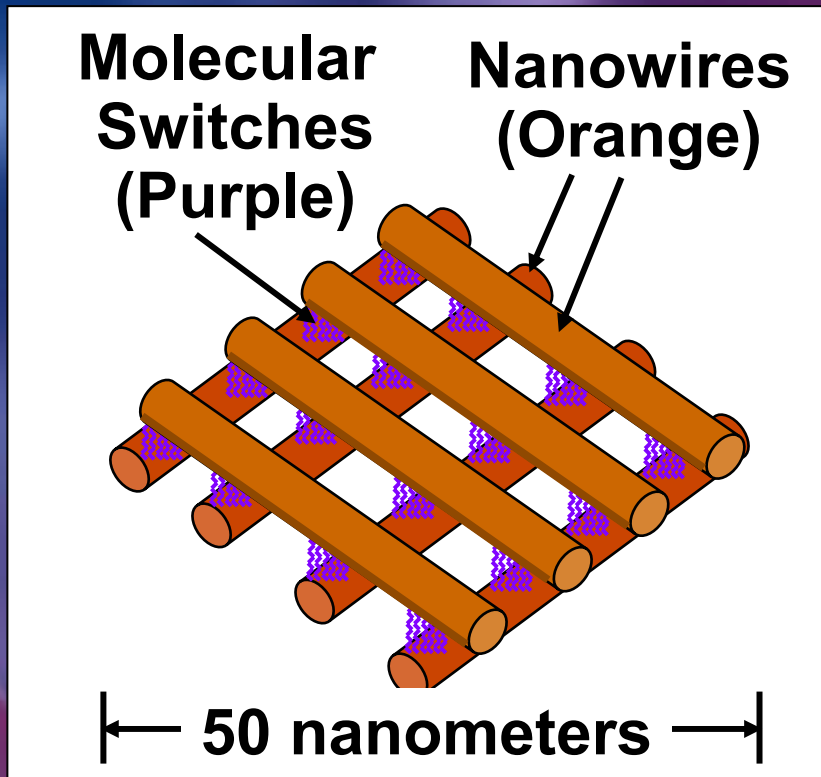
Key Advantages

- ▶ Long retention of molecular memory states
- ▶ *Low power*

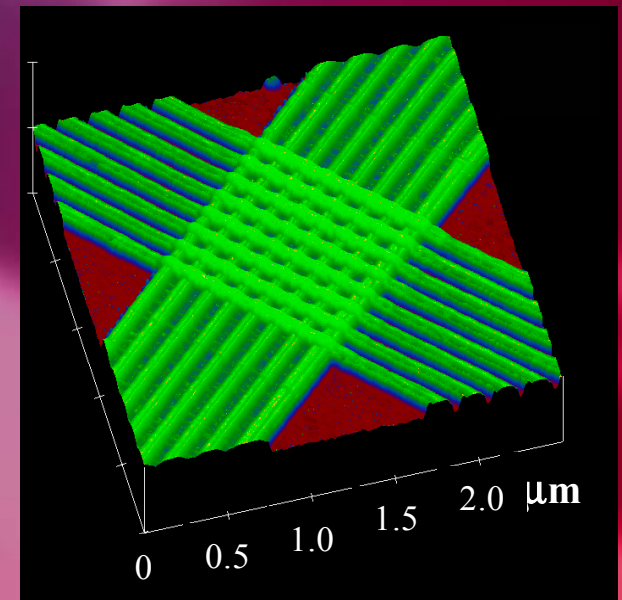


Prototype “Cross-Bar” Memory

Vision

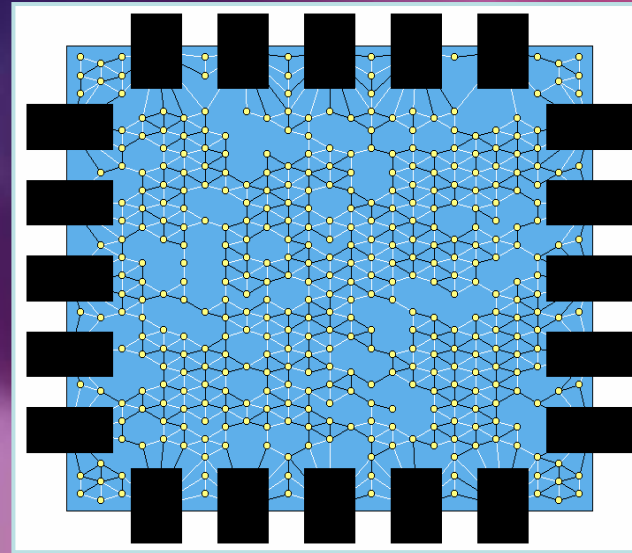


Reality

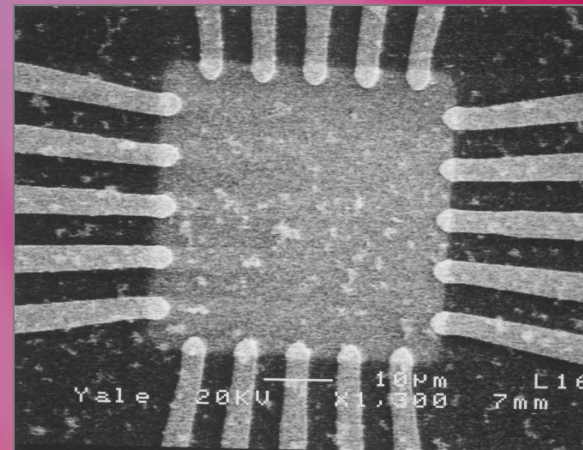


Radical Prototype: The Nanocell

- ▶ Ultra-dense
- ▶ Radically faster and cheaper to build
- ▶ Random assembly
- ▶ Programmed connectivity



Vision



Reality

Realizing the Dream

- ▶ By harnessing the electrical properties of individual molecules...
- ▶ By putting molecules where we want them...
- ▶ DARPA is building a next-generation nanocomputer



Microtechnology to Nanotechnology

- ▶ Critical to our National Defense
- ▶ Essential for preserving the vitality of U.S. information technology industry



Advantages of Molecules

- ▶ “Natural” nanometer-scale structures
- ▶ Can be made inexpensively by the trillions
- ▶ Excellent electrical performance



Nanocomputer Memory in 2004

- ▶ Dramatic increase in density and performance
- ▶ Greater information storage capacity at lower cost



Revolutionary Impacts

- ▶ Dramatic National Defense benefits
- ▶ Stimulating industrial R&D
- ▶ Transforming the nature of computing
- ▶ Computation to become a property of matter



Impact Beyond Computation

- ▶ Helping to create the science and industry of nanostructured materials
- ▶ New wave of innovation



To Summarize...

- ▶ DARPA is realizing the dream of nanotechnology & nanocomputers
- ▶ Will deliver prototype ultra-dense nanocomputer memory in 2004
- ▶ Seeding a revolution in materials as well as in computation





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